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Commentary

Additional Comments on the Study of the Effect of Population Density on the Results of the California Bay Area Study

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The California Bay Area studies concerning ingested asbestos and cancer have been the subject of much discussion. A number of very good questions were brought up after my presentation (*1*) and I would like to address a number of the points.

One questioner asked whether the interconnections of the water supply systems were considered as a factor in my study. I think that the interconnection of water supply systems is an important point regarding the application of asbestos fiber counts from water samples to the levels of asbestos in drinking water of census tracts. For census tracts with more than one source of water, weighted averages of asbestos fiber counts were computed. These averages were weighted for source, treatment process, pressure zone, and/or time.

The question, does the method of calculating population density take into account areas within the census tracts that were unavailable for residential purposes, such as bodies of water and public park lands, is an interesting one. The method for calculating the areas of census tracts did not take into account the portions of census tracts that were unavailable for residential purposes. The boundaries and/or areas of these portions of the census tracts were not accessible. Ultimately the areas within census tracts that were unavailable for residential purposes as well as the areas that were available for residential purposes but were uninhabited should be identified and considered in any analysis including population density.

One questioner asked what the population density criteria were for aggregating census tracts into super tracts. How large a difference in population density between previously separated tracts was permitted? Super tracts were formed by aggregating 1960 and 1970 census tracts such that the boundaries of the super tracts were identical in the two censuses. In many instances, the 1960 and 1970 census tracts were equivalent in which case no aggregation was necessary. The most frequent type of aggregation resulted from the splitting of a 1960 census tract into two or more 1970 census tracts due to increased population over the decade. Although no population density criteria were used in determining the super tracts, population changes were reflected in the population densities of corresponding super tracts.

Another question was whether the socioeconomic and occupation factors included in earlier studies were also included in these analyses? Socioeconomic and occupation variables were included in these analyses. Mean years of schooling and median family income were used as indicators of socioeconomic status. The proportion of workers in construction, electrical, and textile industries indicated the numbers of workers who might have been exposed to asbestos in their occupations. An indicator of marital status was also included in the analysis. This variable was computed as the number of unmarried persons 14 years old and over divided by the total population 14 years old and over.

I was asked to comment on the differences between my associations between asbestos indicators and cancer and the experience reported from the much larger exposures to asbestos in industry. Although I have not considered the comparisons between our results and those of studies of exposure to asbestos in industry, it would seem that since the types of exposure are different

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(inhalation versus ingestion), comparisons are inappropriate. Papers by Marsh and Erdreich (in these proceedings) review and compare studies of ingested asbestos. Their papers may respond to these issues in a more comprehensive way.

I would also like to comment on the differences between my population density associations and those reported by Haenszel (2). One of the differences between the results reported here and the population density associations with cancer reported by Haenszel et al. (2) is that the present study area was a single Standard Metropolitan Statistical Area (SMSA), whereas Haenszel et al. studied the entire state of Iowa. By definition the San Francisco–Oakland SMSA is relatively dense in population. The rural counties and regions of Iowa in 1950 probably were much less population dense than the "rural" census tracts of the 1970 San Francisco–Oakland SMSA. Another difference between the studies is that the Iowa results were sex-specific and age-adjusted, whereas the San Francisco–Oakland SMSA results were sex- and race-specific, age-adjusted, and adjusted for socioeconomic status, asbestos-related industries and marital status. For these reasons, the studies and their results are not really comparable.

It was brought to my attention that from data derived from a National Cancer Institute Monograph (3), the age-adjusted death rates for the five Bay Area counties for six digestive system cancer sites show the highest rates to be in the county with the highest population density. This county, San Francisco County, also had consistently high asbestos counts. A good question then is how was my analysis able to separate these two factors?

The regression approach yields estimates of parameters which reflect the individual contributions of the independent variables (population density, asbestos, and covariables) to the dependent variable (standard incidence ratios of cancer). Regression separates the influences of the independent variables on the dependent variable. The coefficients measure the influence of the independent variables when the values of the other independent variables are held constant. Table 12 of my paper (1) shows the significance of regression coefficients for asbestos and population density for cancer sites in which significant positive associations between asbestos and cancer were observed. The regression coefficients from which these data were extracted indicate that in spite of the fact that population density and asbestos were high in San Francisco county, asbestos was found to be significantly associated with cancer.

Because San Francisco County has high cancer rates, high population density, and high fiber concentrations, a question asked by several was: what consideration was given to the possibility that San Francisco dominated the results and may have biased the entire study in some way? Of the 722 census tracts in 1970, 212 were reported as having 10^7 or more asbestos fibers per liter of drinking water. San Francisco County accounted for 149 of these high fiber concentration census tracts. The other 63 census tracts, 30% of the total high fiber concentration census tracts, came from Alameda and San Mateo Counties. The highest concentrations of asbestos in drinking water were found in San Mateo County. Chi-square tests for linearity were used to evaluate the linearity of the association between asbestos and cancer for four census tract groupings of asbestos. These tests revealed no significant deviation from linearity. A lack of linearity might have indicated an anomaly in the study area due to some unmeasured variable or variables. However, none of the tests for white males showed nonlinearity and only breast, female reproductive, and urinary cancers for white females indicated a departure from linearity for asbestos and cancer. Due to the linearity of the associations between asbestos and cancers and since a large proportion of high fiber concentration census tracts existed outside of San Francisco County, it was concluded that no area in the study dominated the results.

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